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ORIGINAL ARTICLES

FOOD FACTORS IN GASTRO-ENTEROLOGY,[1]

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If one were to interpret the present-day scope of gastro-enterology from the contents of the papers which were presented at the last annual meeting of this Association, it would, I suspect, be difficult to find a place therein for a topic such as I am venturing to discuss at this time. It seems to me, however, that a discipline which relates to "the normal and pathological conditions of the digestive organs" cannot fail to find some interest in the role of the food, for the transformation and transport of which these organs exist, or in the phenomena of nutrition, for which the function of digestion is an indispensable preparation.

There are growing manifestations of a more lively interest on the part of the so-called clinical worker in the contributions of the scientific investigators of the laboratory. It is a platitude to remark that no detail of the fundamental physiology and biochemistry of the alimentary processes should be deemed too insignificant to deserve consideration from the gastro-enterologist. The modern researches on the movements of the digestive canal, the secretions which reach it and the chemical changes which proceed within it are finding applications in diagnosis and therapy of gastro-intestinal disorders. Unfortunately, rational dietetics founded upon the newer knowledge of the chemistry of foods and nutrition has not yet received the discriminating study and advocacy on the part of practical clinicians that its importance unquestionably warrants.

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[1] Read at the meeting of the American Gastro-enterological Society, Atlantic City, June 9, 1919.

We may frankly admit that dietetics is at present far from being an exact science, so that dietotherapy is anything but an accurate art. Nevertheless, the limitations of our knowledge, based, in part, on empiricism and modified by that factor of uncertainty described as personal idiosyncrasy, need not disparage the recourse to novel therapeutic viewpoints and new procedures which new scientific facts are likely to initiate when they are given a sympathetic hearing.

The current attitude of aloofness from sane and helpful dietetics in medical practice is largely engendered by ignorance and indifference, conditions which the recent progress in this field should help to dispel. The widely divergent methods now in vogue in the treatment of gastric ulcer—methods which range from enforcement of complete physiological inactivity and absence of food in the upper alimentary tract, as the one extreme, to liberal feeding, intended to secure better healing through improved general nutrition, as the other extreme—illustrate the place which a fundamental understanding of food factors should have in rational gastro-enterology. Indeed, there are few, if any, specialized departments of medicine which would fail to benefit by greater attention to the fitness of the body as a whole. The physiological functions are so widely correlated and interdependent that there is oftentimes danger of overlooking the major advantage because of a concentration of attention upon a more obvious minor defect.

FOOD AND DISEASE DURING THE WAR. The exigencies of the World War and the unusual food situations created by it have compelled thousands upon thousands of persons to alter their traditional modes of nutrition or their customary dietary habits. This change has not been instituted without many protests. Even the finest spirit of patriotism could not always repress misgivings regarding the physiological wisdom of the enforced or recommended innovations of diet. All physicians, probably, can substantiate my assertion that the medical profession received many anxious appeals to corroborate the alleged safety of the dietary restrictions which the governments demanded in the interest of the win-the-war policy. Many of the proposals cost the responsible officials of our Food Administration no little anxiety lest the substitutions and economies and the food sacrifices and modifications of diet might in any way alter the well-being of our population. During the war we have learned the possibility of using more than one cereal to advantage; we have succeeded in lowering the consumption of meat without apparent detriment; we have reduced the intake of sugar to the plane where it represented a condiment rather than a food; we have restored the conserved and less expensive vegetables to a worthy place in the day's food—these and other dietary changes have been instituted amid the fears of the devotees of custom in foods.

It must not be assumed, however, that the enforced war-time restrictions have been attended everywhere with equal nutritional success. The effects of the difficulties in the food situation in the Central Empires of Europe upon the health of their peoples have recently been reported by a no less competent observer than Prof. F. Kraus,[2] of the Charité Hospital in Berlin. Addressing the members of the medical profession, he referred, in the domain of gastro-enterological disorders, to the numerous cases of intestinal dyspepsia provoked by the monotonous, voluminous diet preponderating in difficultly digestible carbohydrates; to the gastric dyspepsias attended with achylia, less often with diarrhea; to the intestinal fermentations; above all to the induced constipation, flatulence and the induced or augmented catarrhal condition of the bowel; and likewise to an increased incidence of ulcer. Furthermore, Kraus alleged that, among numerous persons in all walks of life, the monotony of the crude diet, the lack of gustatory stimuli and suitable food accessories, and possibly of vitamines, have induced a degree of anorexia or food satiety which has ultimately been followed by inanition. Surely the recital of these untoward experiences affords a cogent argument for a better appreciation of the specific role of the individual nutrients not merely in the physiology of digestion, but also in the clinic of gastro-enteric disease.

Some Newer Viewpoints. If we turn to the innovations of viewpoint which the newer physiology offers as worthy of the attention of the gastro-enterologist the modern conception of secretion becomes conspicuous. Twenty years ago, when this Association was still in its infancy, the mechanism of the control of the glandular activities, which are so important in relation to alimentation, was believed to reside in the nervous system. Secretion was conceived to be initiated or inhibited, as the case might be, through the medium of nervous impulses. Today a humoral path of stimulation through the intermediation of chemical substances—hormones or succagogues carried in the blood stream—is becoming well recognized. I cannot but believe that if the various chemical stimulants to secretion, particularly as they occur in our diet ingredients, were better known and appreciated the information would find more frequent application, particularly in relation to the promotion of gastric secretion. It is not too much to hope that selected foods and related substances may before long be expected to accomplish for secretion some of the effects which drugs are at present often called upon to bring about.

Vitamines and Gastro-enterology. The word "vitamine," scarcely five years old, has already become an expression to conjure with. The vague and mysterious characteristics with which it is at present endowed will, I feel confident, gradually acquire a more specific significance as the potencies of "the hitherto unidentified food factors indispensable to normal nutrition" are elucidated by further research. Consider the following striking experimental demonstrations: An animal is placed upon a diet consisting of isolated proteins, carbohydrates, fats and inorganic salts—the traditional mixture of nutrients which the physiology of our teachers has led us to expect to be adequate for the body's needs. Nutritive failure and decline will inevitably ensue, attended by a variety of symptoms, perhaps including those seen in beriberi. An exceedingly small dose of brewers' yeast or a chemical fraction prepared therefrom, or a small allowance of a vegetable like the tomato, spinach or carrot, or an addition of milk or of any of a large variety of naturally occurring foods to the dietary, will bring a restitution of health with a speed and completeness that is little short of marvellous. We are face to face in such instances with the nutrition-promoting potency of something which cannot be expressed in terms of the hitherto recognized nutrients. A ration compounded of washed skeletal muscle (beefsteak), carbohydrate, fat and salts leads to analogous nutritive failure; whereas, the substitution of liver or kidney tissue for the meat, in an otherwise unaltered diet, ensures uninterrupted well-being. In terms of the current hypothesis we have become accustomed to say that the yeast, the vegetables, the milk, liver, and kidney contain an essential food factor or vitamine.

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[2] Berl. klin. Wchnschr., January 6, 1919, p. 3.

Again, if in an otherwise adequate dietary the sole source of fat is represented by lard or one of the familiar vegetable oils, nutritive disaster will ensue sooner or later. During the period of pronounced malnutrition serious eye disease may arise as one of the intercurrent symptoms. The introduction of a small amount of milk fat, liver fat (as in cod-liver oil) or the oil of some of the vegetables, as Osborne and I have lately demonstrated, brings about an almost magical restitution of health. Here evidently we are concerned with the presence in certain of the fats or fat-like mixtures of another potent property distinct from the vitamine already described. To these illustrations, so striking that they are not easily forgotten by one who has witnessed the surprising remedial transformations induced by seemingly insignificant quantities of certain food products, may be added the presumably distinct antiscorbutic properties of certain natural foods.

The purpose of these fragmentary references to significant features in the recent studies of nutrition is not to emphasize primarily their broader dietary significance. I desire rather to offer the suggestion that dietary deficiencies, such as are exemplified by the lack of suitable vitamines in the ration, may affect the gastro-enteric tract quite as probably as other parts of the organism which are represented in the now recognized so-called deficiency diseases. The gastro-intestinal symptoms in pellagra afford a specific illustration.

At the present stage of our knowledge the gastro-enterologist cannot afford to overlook the possible role of the vitamines in the functions of those parts of the organism with which he is most directly concerned.

In a recent interpretation of the nature of appetite Carlson[3] wrote:

> "Appetite depends not only on the memory process of past experience, with palatable food as positive phases and the memory process of removal of hunger pangs by feeding, but the presence of this memory process in consciousness depends on certain conditions of the alimentary tract. When the stream of afferent impulses from the alimentary tract and possibly other visceral organs becomes altered in quantity or quality from the normal these impulses suppress or render impossible the existence of appetite. Hence it would appear that the existence of appetite is an indication of a proper condition of the alimentary tract to handle the food in the way of motility and secretion, and that this is the chief biological significance of appetite. The production of appetite gastric juice is of secondary importance and of practical significance only in cases of extreme impairment of gastric secretion."

We have frequently observed that one of the conspicuous manifestations of a dietary regimen deficient in certain types of vitamines is a diminished food intake. The feeding of vitamine-containing products almost always results in an improved appetite, if one may judge this by the resulting ingestion of increased amounts of the same ration which was refused on the vitamine-free regimen. Precisely what the decisive relationships here are—whether improved appetite induced by the vitamine leads to better food intake and hence better nutrition or whether nutrition improved by the potent food factor results in better appetite—can scarcely be decided at the present time. At any rate the possible bearing of vitamines on the problem of appetite and alimentary well-being should not be overlooked by those who are interested in the physiology and pathology of the gastro-enteric tract.

PROTEIN FACTORS. In considering the role of albuminous substances in nutrition the gastro-enterologist is confronted with the unlike digestibility of proteins from different sources. Thus the proteins of some of the legumes, notably beans, are admittedly more resistant to the enzymatic digestive changes than is the case with proteins from many other sources of both animal and vegetable origin in the alimentary canal. Why this is true remains to be elucidated. The tendency for native egg-white to be poorly utilized in the digestive tube has been emphasized by the investigations of Bateman[4] in our laboratory. He has summarized the objections to the use of raw eggs, which is still widely advocated by some physicians, as follows:

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[3] New Aspects of the Significance of Appetite and Appetite Gastric Juice in Practical Medicine, Interstate Med. Jour., 1917, No. 5, vol. xxiv.

[4] The Use of Raw Eggs in Practical Dietetics, AM. JOUR. MED. SC., 1917, cliii, 841.

"A substance which fails to stimulate a flow of gastric juice and is antipeptic, which hurries from the stomach, calls forth no flow of bile and strongly resists the action of trypsin, which is poorly utilized and may cause diarrhea, has evidently little to recommend it as a foodstuff of preference for the sound person, let alone for the invalid. And when the native protein needs only to be coagulated at 70° in order to obviate almost all the effects mentioned, there appears still less reason for using it uncooked. Other considerations strongly support this conclusion."

Another illustration of the resistance to digestion on the part of a protein substance, presumably complete in its chemical make-up, is furnished by wheat bran. If further evidence were needed to demonstrate the failure of its protein to be utilized one could cite the latest experiments on man by Holmes.[5] Even when wheat bran was ground very fine so as to be rendered more pervious to the digestive secretions the "coefficient of digestibility" did not exceed 45 per cent. Indeed, the advocacy and success of wheat bran as a laxative is based in part at least on this resistance to alimentary digestion.

The three instances just cited exemplify the objections to the use, as nutrients, of protein products known to be difficultly digestive because of either chemical composition or physical texture. Such foods must often be excluded in dietotherapy when an undigested alimentary residue, susceptible to microbial changes, with the possible attendant symptoms of intestinal disorder, needs to be avoided. On the other hand it must not be assumed that every protein which is digested with great readiness and completeness in the alimentary tract is on this account an ideal component of the ration. Gelatin is conspicuous for the readiness with which it yields to the proteolytic enzymes of the intestinal canal; despite this easy digestibility, however, it is an "incomplete" protein in the sense that it fails to furnish some of the amino-acids that are indispensable for perfect nutrition. This fact has long been known; and while the use of gelatin as a supplementary food can only be commended, its limitations as the sole source of nitrogen deserve to be reiterated at a time when a concerted effort is apparently being made to increase the consumption of the product.

Again, there are instances of proteins or protein mixtures which are not absolutely defective or incomplete in the sense referred to in the discussion of gelatin, yet are comparatively deficient in the yield of certain "building stones" essential for nutrition. Thus the proteins of wheat flour are easily digested and utilized in the usual sense. Compared with many other proteins, however, they are not economical sources of the nitrogenous nutrient units. Osborne and

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[5] Experiments on the Digestibility of Wheat Bran in a Diet without Wheat Flour U. S. Dept. Agric., Bull. 751, 1919.

I[6] have recently demonstrated that flour used as the sole source of protein is inferior to many other foods in maintaining adult rats, and especially in promoting the growth of the young. But when the proteins of wheat are fed in combination with about one-third of their weight of the proteins furnished by eggs, meat or milk these cereal proteins are so greatly enhanced in value that flour is thus used most advantageously. In fact, by far the greater part of the flour used in this country in every-day life is actually eaten in combination with those food products which successfully supplement the nutritive deficiencies of its proteins. Adequate nutrition means something more than calories and digestible nutrients; the components of the diet must be appropriate in quality as well as quantity and all of the essential units must be represented.

THE INORGANIC ELEMENTS. In a recent text-book it is stated:

"The mere enumeration of a few of the important uses of the inorganic elements brings out strikingly their significance. The multiplicity of their function has likewise rendered the study of these substances difficult, for with one element having a varied function its removal from the diet may be responsible for many secondary reactions which will mask the direct result.[7]"

Despite such generalizations it must be admitted that our knowledge of the functions of the inorganic elements in the body is still very fragmentary and indefinite. As Osborne and I have written elsewhere:[8] "Although there is almost unanimity of opinion regarding the energy needs of the body under different circumstances of age and activity; although the current estimates of the minimum amount of protein required per day seem to be defined within reasonably narrow limits; although the functions of fat and carbohydrate and the possibilities of their interchange are beginning to be understood; there is no adequate experimental basis whatever to permit tenable statements regarding either the indispensability or the minimum requirement of any of the inorganic constituents of the dietary, with the possible exception of calcium and phosphorus. Statistics show enormous divergencies between the mineral intakes of people in different regions; but these appear to be the fortuitous results of widely unlike dietaries, including water (as is the comparative dissimilarity in the fat and carbohydrate content of the diets of peoples living respectively in a tropical or frigid climate—differences enforced by the unlike character of the available food supplies) rather than the expression of unlike metabolic needs. A beginning has hardly been made in this field of investigation."

The need of certain elements for structural purposes in the body is obvious. The possible part which some may play in the obscure role of "maintaining osmotic equilibrium" is less certain, and when the assumed balance of acids and bases is discussed the border-line of accurate knowledge respecting the individual elements is reached. In studying growth under conditions in which the specific inorganic content of the ration could be fairly well controlled, each element being increased or diminished as desired, Osborne and I found that a lack of calcium or phosphorus promptly effects untoward results. The need of the other familiar inorganic elements, however, appeared to be unexpectedly small. This applied particularly to chlorin, and is presumably true of some of the other elements like sodium, potassium and magnesium. As we have pointed out: "That these may to some degree be essential to the adjustments of neutrality regulation is indicated by the failure to grow when both sodium and potassium were practically excluded from the diet, whereas growth was nearly or quite normal when only one of these elements was missing. That these elements take part in the processes regulating the neutrality of the body fluids is to be assumed from what has been learned by experimental work *in vitro* along these lines, and also from the fact that our experiments with diets essentially free from both sodium and potassium have led to nutritive failure." We concluded that in the long run much smaller quantities of those inorganic elements which can be husbanded will be required for well-being than of those which are needed for the maintenance of neutrality, and hence are continuously eliminated, wholly apart from any quantity necessary for the construction of special tissues like bone or for the production of milk.

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[6] The Nutritive Value of the Wheat Kernel and its Milling Products, Jour. Biol. Chem., 1919, xxxvii, 557.

[7] Carter, Howe and Mason: Nutrition and Clinical Dietetics, Lea & Febiger, 1917, p. 78.

[8] The Inorganic Elements in Nutrition, Jour. Biol. Chem., 1918, xxxiv, 131.

The gastro-enterologist is peculiarly interested in the role of chlorin in the organism because of the indispensability of this element in the elaboration of the gastric juice. Common salt has frequently been prescribed to supplement diets presumably poor therein, with the avowed object of averting any failure of hydrochloric acid secretion, particularly because anacidity has been reported as a consequence of a salt-free diet. It must now be borne in mind, however, that when the intake of chloride is restricted the output promptly decreases. In starvation it is almost *nil*. Whatever chlorin is secreted into the stomach is subsequently reabsorbed and consequently conserved. The feces in health carry away little if any chloride. Referring to observations on man, Sherman states that even when there was complete deprivation of salt during ten to thirteen days the total loss did not exceed 10 to 15 per cent. of the amount estimated as usually present in the body. Rosemann has demonstrated that a diet deficient in chlorides leads at most to an insignificant reduction of the total chlorin content of the body in animals. Excretion of the element stops under such conditions, but signs of malnutrition are speedily elicited when chlorin is withdrawn from the body by actual removal of the hydrochloric acid of the gastric juice through a fistula. Until losses are thus artificially enforced the gastric juice tends to maintain essentially its normal content of hydrochloric acid.

The ability of the animals, which Osborne and I observed, to continue in health for a time on a diet low in chlorin might therefore have been anticipated; but, as we have remarked elsewhere, it could not have been expected that they would continue to thrive so long or attain so many times their original weight on such an extremely low chlorin intake. The outcome of these experiments cannot be due to substitution of other anions for chlorin but is attributable to a husbanding of this specific element. From the therapeutic standpoint the demonstration that a growing animal can fully supply from inorganic sources its requirements of the inorganic elements emphasizes anew that it is unnecessary to consider the presence of calcium, phosphorus and iron, for example, in natural foods to the degree that is currently believed.

FOOD AND THE INTESTINAL FLORA. There are times when the bacterial invaders of the alimentary tract give much concern to the gastro-enterologist. It is, of course, true that microörganisms are always harbored in the recesses of the bowel, but the intestinal flora is by no means a constant one. On rare occasions specifically pathogenic bacteria are present. Under ordinary circumstances the types include more familiar putrefactive organisms, on the one hand, or acidophile bacteria, on the other. Herter and his associates were the first to demonstrate clearly the dependence of the types of bacteria developing in the alimentary canal upon the chemical character of the diet. In general it may be said that abundance of carbohydrates tends to favor the preponderance of the acid-forming types, whereas proteins permit the appearance of putrefying bacteria. Thus one may recall Torrey's observations on the effect of various high-calory diets upon the fecal flora of typhoid fever patients. It was shown by him that with some cases if lactose were added in amounts of 250 to 300 grams a day to the other ingredients of the Coleman-Shaffer diet there resulted a transformation of the fecal flora from the ordinary type to one strongly dominated by B. acidophilus. As an added illustration of the fundamental way in which the types of bacteria vegetating in the intestine can be controlled by the chemical character of the food ingested I shall quote from the more recent studies by Torrey:[9]

"In feeding experiments with dogs it has been shown that two carbohydrates, lactose or dextrin, when added to a meat and rice diet caused such a marked development of aciduric bacteria of the B. acidophilus type that they completely dominated the fecal flora and effected the almost complete suppression of proteolytic types commonly found in the canine intestinal tract, even including B. coli.

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[9] The Regulation of the Intestinal Flora of Dogs through D et, Jour. Med. Research 1919, xxxix, 415.

This purely fermentative flora would, furthermore, persist as long as the diet was continued, there being no tendency to reversion to the so-called normal flora. B. bifidus sometimes increases greatly under these dietary conditions, but generally was soon overgrown and suppressed by B. acidophilus, and, in fact, very rarely became the dominant type. A diet of bread and milk, which naturally contains both lactose and dextrin, was also followed by the establishment of a fecal flora consisting almost entirely of B. acidophilus."

Again, Torrey writes:

"Starchy foods all tended to effect a simplication of the intestinal flora and an elimination of obligate putrefactive bacteria. These foods with a large starch content differed in some degree in their efficiency as transforming agencies. White bread, potatoes and beans all tended to bring about a predominance of B. acidophilus, whereas rice proved rather less effective as an antiputrefactive agent."

And of the protein factor Torrey has this to say:

"Various proteins were found to differ radically in their effect upon the intestinal flora, depending upon their source. Of the varieties tested the proteins of mammalian tissues were the only ones which markedly encouraged the growth and activity of the obligate putrefactive bacteria within the intestinal tract. A diet of fish brought to development a flora which was entirely different from that appearing in association with the feeding of beef hearts. Spore-bearing bacteria did not appear in the fecal specimens in more than insignificant numbers. There was a notable absence of the B. welchii types which constitute so large a part of the flora in connection with a meat diet. On the other hand, bacteria of the B. coli and B. proteus types were strongly predominant. Milk casein as an article of diet exhibited far less tendency to give rise to intestinal putrefaction than did meat protein. . . . Vegetable proteins stand in strong contrast to animal proteins, especially meat, in that they do not offer the slightest encouragement to the growth of intestinal putrefactive types of bacteria. In fact, with a bread containing a very high protein content with a minimum of carbohydrate as marked an overgrowth of aciduric intestinal bacteria occurred as was observed in connection with diets to which considerable amounts of lactose or dextrin had been added."

It is needless to multiply quotations. They are concordant in suggesting that diet can probably be made a more potent factor than are ingested bacterial cultures in regulating putrefactive conditions in the bowel. The determination of the conditions under which desired intestinal floras can be established opens a fruitful field for the clinical investigator.

Dietetics offers no cure-alls to the gastro-enterologist, nor does any other mode of therapy. Calories, proteins, vitamines, acidophilic bacteria—these merely furnish viewpoints from which important problems of practice may be examined. The student of foods and nutrition is wont to be reminded that "a little knowledge is a dangerous thing." This is doubtless true, but I cannot gain the conviction that utter ignorance is a safety device. My sole justification for presenting a consideration of some food factors in nutrition has been the hope that the fragmentary items hastily reviewed may perchance suggest new possibilities in the practice of gastroenterologists. Huxley once wisely remarked that science commits suicide when it adopts a creed. The open mind continually receptive to new suggestions guarantees a more healthful life.

OBSERVATIONS IN THE TERMINAL STAGE OF A CASE OF HEPATIC CIRRHOSIS.

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The patient in question was a private, aged twenty-nine years, born in Italy, and a barber prior to being drafted into the military service. His father died at fifty-nine of unknown cause. His mother, one brother and three sisters are alive and well. He gave a history of measles in childhood, chancre or chancroid six years ago, for which he received two salvarsan and two mercury injections at the time, and gonorrhea three years ago.

Otherwise he was well until a left inguinal hernia appeared two years ago and one on the right side six months later. He was admitted to the hospital July 28, 1919, for operation, and the examinations on the surgical service showed nothing wrong except the hernias. He deserted August 7, was brought back August 29 and the hernias were repaired by Andrews' method under ether on September 3. Very large scrotal hematoma ensued, and on account of persistent oozing a coagulose injection was given on September 6. The wounds broke down and healed slowly by granulation, with return of the hernias. Large quantities of blood were passed by bowel on the days following operation. Fluid accumulation in abdomen coming on during this time was assumed to be due to hemorrhage. October 21 to 28 the patient went through typical influenza, which was then epidemic in the hospital. On the medical service the abdomen was tapped November 6, removing 7500 c.c. clear fluid, which gave a two-plus Wassermann reaction. Careful physical examination revealed nothing abnormal except a distinctly palpable spleen; the liver was not enlarged. Investigation was interrupted by the escape of the patient on November 8, due to his feeling so well after tapping. He was brought back February 19,